OPERATING AND SERVICE MANUAL

-hp- Part No. 00209-90002

MODEL 209A
SINE/SQUARE OSCILLATOR

Serials Prefixed: 818-

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

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Table 1-1. Specifications

—— RANGES ——

Frequency: 4 Hz to 2 MHz in 6 ranges.

—— PERFORMANCE RATINGS ——

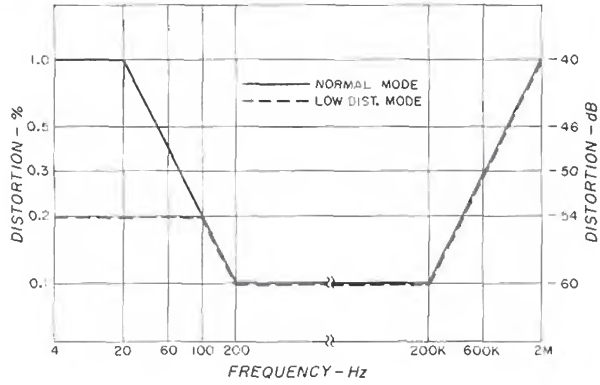
Dial Accuracy: +/-3% of frequency setting.

Flatness: At maximum output into 600 ohm load. 1 kHz reference.

Low Distortion Mode	+/-1%	+/-0.5%	+/-1%	+/-5%
Normal Mode	+5% -1%	+/-0.5%	+/-1%	+/-5%

(Hz) 4 100 300k 1M 2M

Distortion:



Hum and Noise: less than 0.01% of output.

—— OUTPUT CHARACTERISTICS ——

SINE WAVE

Output Voltage: 5 V rms (40 mW) into 600 ohms; 10 V open circuit. Output can be floated up to +/-500 V peak between output and chassis ground.

Output Impedance: 600 ohms.

Output Control: 20 dB range continuously adjustable.

Output Balance: greater than 40 dB below 20 kHz.

SQUARE WAVE

Output Voltage: 20 V p-p open circuit symmetrical about 0 V. Output can be floated up to +/-500 V peak between output and chassis ground.

Rise and Fall Time: less than 50 ns.

Symmetry: +/-5%

Output Impedance: 600 to 900 ohms depending upon setting of output control.

—— EXTERNAL SYNCHRONIZATION ——

Sync Impedance: 10 kilohm.

Sync Output: Sine wave in phase with output; amplitude working into 1 megohm shunted by 100 pF is greater than 1.7 V rms from 4 Hz to 50 kHz, greater than .1 V from 50 kHz to 2 MHz.

Sync Input: Oscillator can be synchronized to external signal. For 5 V rms input, sync frequency can be as much as +/-7% away from set frequency (sync range). Sync range is a linear function of sync voltage.

—— GENERAL ——

Operating Temperature: Instrument will operate within specifications from 0% C to 55% C.

Storage Temperature: -40% C to +75% C

Power: AC-Line 115V or 230V +/-10%, 48 Hz to 440 Hz, less than 7 W.

Dimensions:
Refer to Figure 2-1, page 2-2.

Accessories Available: HP 11075A Instrument Case.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the -hp- Model 209A Sine/ Square Oscillator. Throughout this manual the instrument will be referred to as the Model 209A.

1-3. SPECIFICATIONS.

1-4. Table 1-1 lists the specifications for the Model 209A.

1-5. DESCRIPTION.

1-6. The Model 209A is a versatile signal source with independent sine wave and square wave outputs at frequencies from 4 Hz to 2 MHz. The square wave amplitude is variable to a maximum of 20 volts peak-to-peak into open circuit. The sine wave amplitude is variable to a maximum of 10 volts rms into open circuit from a constant 600 ohm source. When working into a 600 ohm load, the maximum output level is 5 volts rms.

1-7. Balanced output can be obtained by disconnecting the grounding strap at the rear of the instrument. This isolates the chassis from the cabinet and line ground. The sine wave output will balance to greater than 40 dB, at frequencies below 20 kHz, with the chassis isolated.

1-8. The Model 209A can be synchronized with an external source. With a 5 volt rms sync input, the external source may vary as much as +/-7% in frequency and the Model 209A will remain synchronized.

1-9. A sync output of 1.7 volts rms is also available at the same front panel terminal used to accept an external sync source.

1-10. INSTRUMENT/MANUAL IDENTIFICATION.

1-11. Hewlett-Packard uses a two-section serial number. The first section (prefix) identities a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial prefix of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments or the backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

Figure 1-1. Model 209A Sine/Square Oscillator

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installing and shipping the Model 209A Sine/Square Oscillator. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage that occurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Test the electrical performance of the instrument using Performance Checks outlined in Section V. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The standard Model 209A will operate from any source of 115 or 230 volts (+/-10%), at 48 to 440 Hz. With the instrument disconnected from the ac power source, move the voltage selector switch (located on the rear panel) so the designation appearing on the switch matches the voltage of the power source to be used. Power dissipation is less than 7 watts.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument cabinet be grounded. The standard Model 209A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground connection.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to earth ground.

2-10. INSTALLATION.

2-11. The Model 209A is fully transistorized; therefore, no special cooling is required. However, the instrument should *not* be operated where the ambient temperature exceeds 55° C (131° F).

2-12. BENCH MOUNTING.

2-13. The Model 209A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. RACK MOUNTING.

2-15. The Model 209A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of -hp- submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service office. (See Appendix B for office locations.)

2-16. COMBINATION MOUNTING.

2-17. The Model 209A may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module unit.

2-18. REPACKAGING FOR SHIPMENT.

2-19. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-20 if the original container is to be used; 2-21 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

2-20. If the original container is to be used, proceed as follows:

a. Place the instrument in the original container if available. If the original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that the container is well sealed with strong tape or metal bands.

2-21. If the original container is not to be used, proceed as follows:

a. Wrap the instrument in heavy paper or plastic before placing it in an inner container.

b. Place packing material around all sides of the instrument and protect the panel face with cardboard strips.

c. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark the shipping container with "DELICATE INSTRUMENT", "FRAGILE" etc.

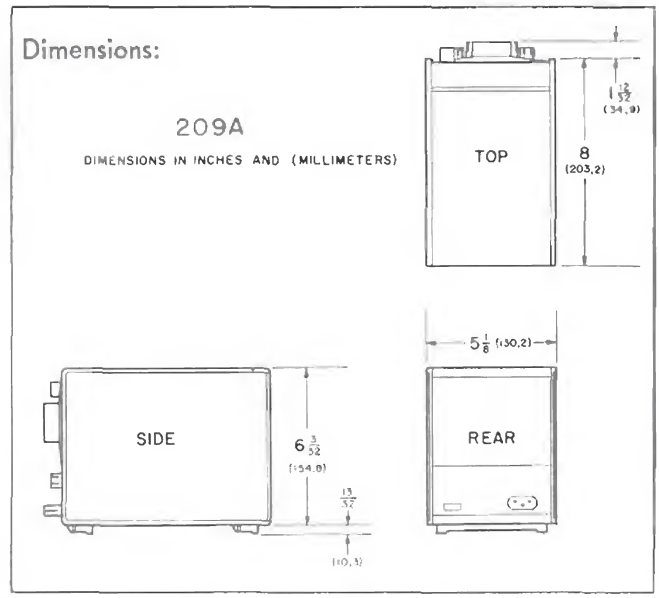
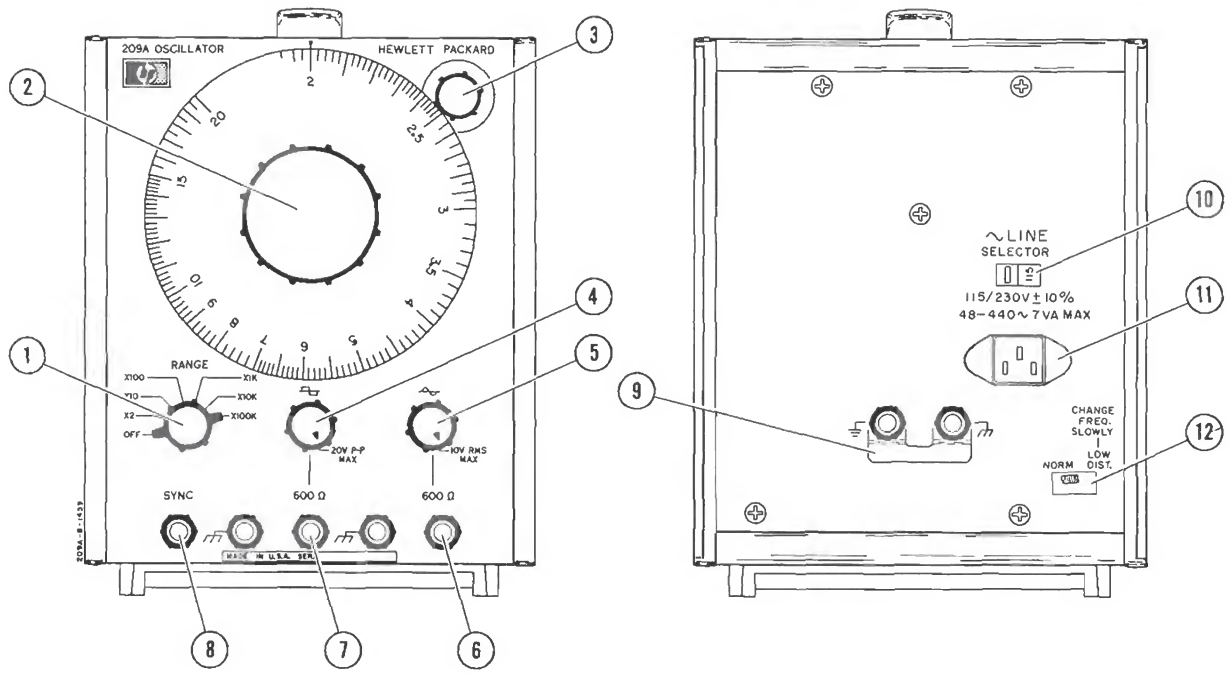


Figure 2-1. Dimensions



(1) RANGE Switch: Selects frequency range or OFF position.

(2) Frequency Dial: Selects frequency within desired range. Dial setting multiplied by RANGE switch position indicates output frequency.

(3) Frequency Vernier: Provides fine tuning of frequency dial.

(4) Square Wave Amplitude Control: Varies Square Wave output level to 20 volts peak-to-peak, open circuit.

(5) Sine Wave Amplitude Control: Varies Sine Wave output level over a 20 dB range to 10 volts rms, open circuit (5 volts rms into 600 ohms).

(6) Sine Wave Output Terminal: 600 ohm sine wave output at a frequency and amplitude determined by control settings.

(7) Square Wave Output Terminal: 600 ohm square wave output at a frequency and amplitude determined by control settings.

(8) SYNC Terminal: (1) Input terminal for an external sync signal. (2) Output terminal for 1.7 volt rms sine wave sync signal.

(9) Ground Strap: Connects the floating circuit ground to power ground.

(10) Voltage Selector Switch: Selects line voltage of 115 volts or 230 volts AC.

(11) AC Power Receptacle: Mates with power cord supplied with this instrument for line voltage connection.

(12) NORM/LOW DIST. Switch: Selects normal or low distortion below 100 Hz.

Figure 3-1. Description of Controls and Connectors

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains information as an aid to operating the Model 209A. Included are control and connector descriptions (Figure 3-1), and some special operating considerations.

3-3. TURN ON PROCEDURE.

3-4. To turn on the Model 209A, proceed as follows:

a. Set the two-position voltage selector switch on the rear panel to the value of available line voltage.

b. Connect the AC power cord to line voltage.

c. Switch the RANGE switch from OFF to the desired frequency range.

d. Select the desired frequency and voltage output with the frequency dial and amplitude controls respectively.

3-5. OPERATING CONSIDERATIONS.

3-6. FLOATING OUTPUT.

CAUTION

WHEN THE GROUND STRAP ON THE REAR PANEL IS CONNECTED, INPUT GROUND IS AT EARTH GROUND POTENTIAL.

3-7. When the ground strap on the rear of the Model 209A is disconnected, the chassis is isolated from power ground. The outputs may then be connected to any point with a dc potential of not more than +/-500 volts. If a dc voltage up to +/-500 volts is connected between the ground connectors on the rear panels, the oscillator output is dc offset by that amount.

3-8. BALANCE.

3-9. With the chassis isolated from the cabinet, the sine wave output will be balanced to greater than 40 dB at frequencies below 20 kHz. If the square wave output is being used simultaneously with the black terminal connected to ground, the sine wave output will no longer be balanced.

3-10. SYNCHRONIZATION.

3-11. The Model 209A is equipped with a SYNC terminal that provides a sync output signal or accepts a synchronizing input signal from an external source. The sync output signal is a 1.7 volt rms sine wave in phase with the oscillator output. The external sync signal can be any periodic waveform of sufficient amplitude to maintain sync. For an external sync signal with an amplitude of 5 volts rms, the oscillator will remain synchronized at frequencies of +/-7% of the set frequency.

3-12. The Model 209A can be synchronized to any significant harmonic of an external signal. However, if a harmonic or non-sinusoidal waveform is used to synchronize the Model 209A, some portion of the external sync signal will be on the output. This small signal will appear as distortion. The amount of this apparent distortion will be directly proportional to the amplitude of the sync signal. For a non-sinusoidal sync input of 2 volts peak-to-peak, the distortion will be down about -45 dB for frequencies which are normally down -60 dB.

3-13. LOW DISTORTION.

3-14. At frequencies below 100 Hz, distortion can be reduced by switching the NORM/LOW DIST switch on the rear panel to LOW DIST. In the LOW DIST mode the Model 209A will have a longer settling time when changing frequencies. To avoid this, set the desired frequency before switching to LOW DIST.

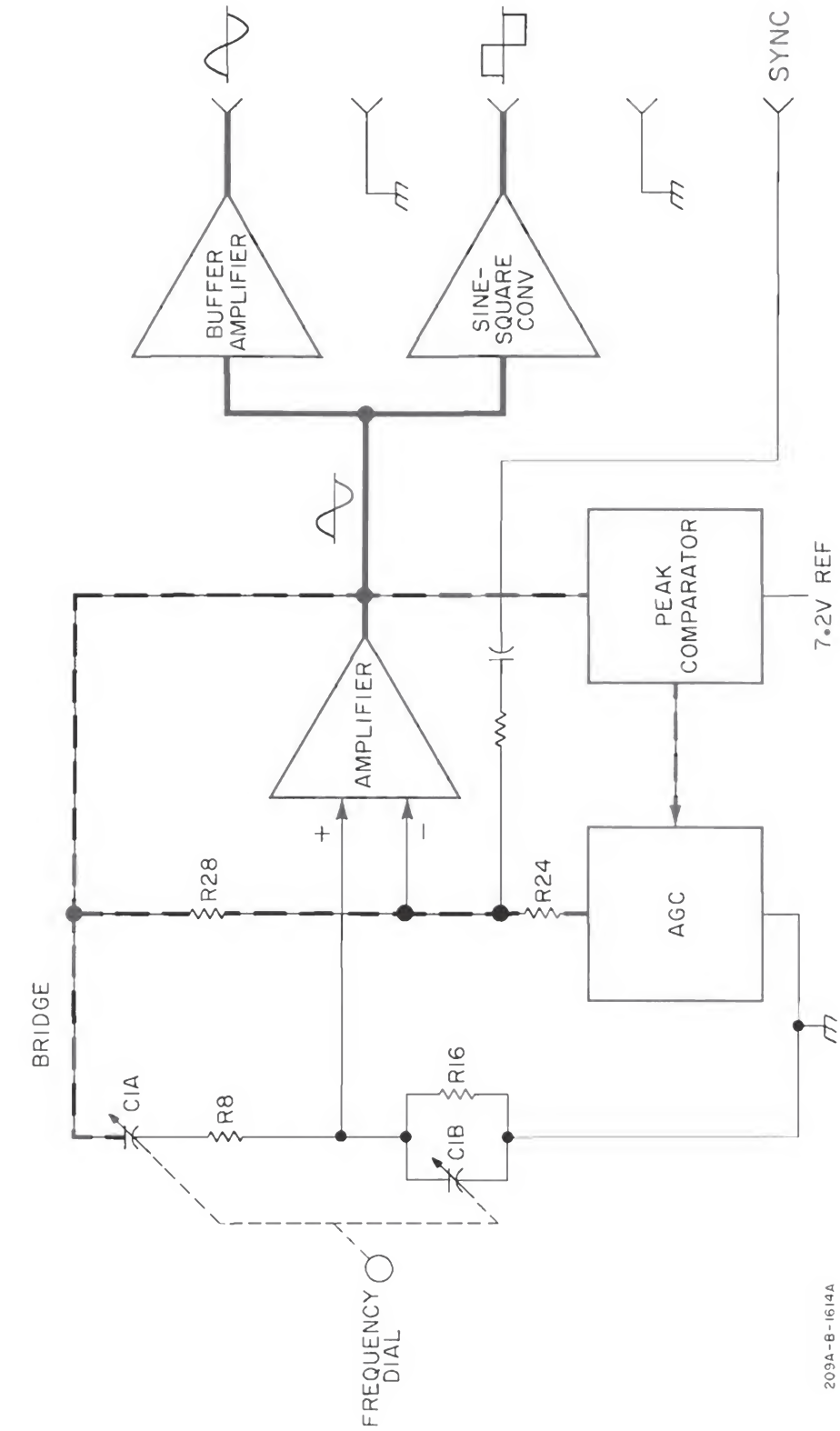


Figure 4-1. Model 209A Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the basic principles of circuit operation for the Model 209A. The information is presented as a discussion of each block indicated on the Block Diagram, Figure 4-1, and detailed circuit descriptions which refer to Figure 7-1 and 7-2.

4-3. The Model 209A is basically a Wien bridge oscillator. The output from the oscillator circuit is applied to a buffer amplifier and to a sine wave to square wave converter. These two circuits provide independent sine wave and square wave outputs, respectively.

4-4. BLOCK DIAGRAM DESCRIPTION.

4-5. BRIDGE AND AMPLIFIER.

4-6. An overall loop gain of at least unity is a requirement for any amplifier to oscillate. The Model 209A satisfies this requirement with a combination of positive and negative feedback through the bridge.

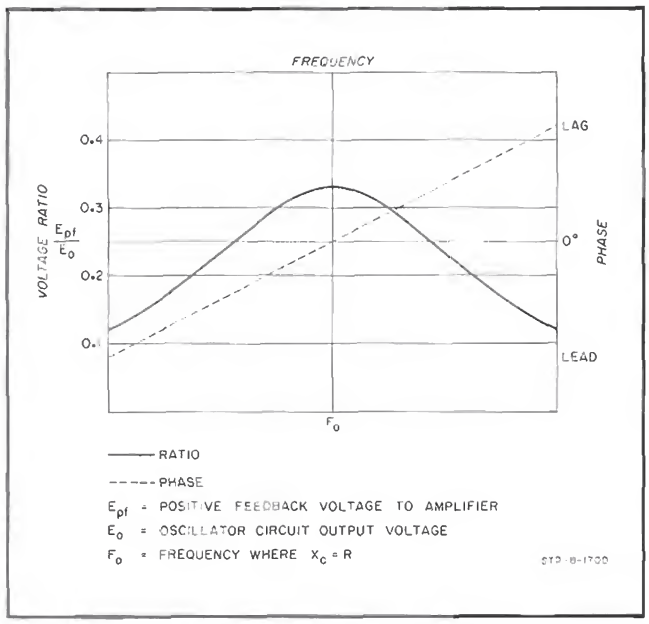


Figure 4-2. RC Frequency Network Characteristics

4-7. The oscillator bridge is divided into two networks, the frequency selective network and the negative feedback network. Positive feedback is furnished through the frequency determining network of C1A, R8, C1B, and R16. At the frequency that the phase of the positive feedback is 0^o, $X_c = R$ and the maximum ratio of output voltage is supplied to the amplifier (see Figure 4-2). The characteristics of the Wien bridge are such that the output voltage to the + input of the amplifier at F_o is one third the amplitude of the positive feedback voltage. Therefore, to maintain unity gain and oscillation, the negative feedback network (R28, R24 and AGC) was designed with a divider ratio of two to one, to give the amplifier a gain of three.

4-8. The amplifier itself is a solid-state, high gain amplifier with the output in phase with the input so that feedback will produce oscillations.

4-9. PEAK COMPARATOR AND AGC.

4-10. The voltage output from the Wien bridge to the input of the amplifier is not always one third of the positive feedback voltage at all operating frequencies, nor is the amplifier gain constant for all operating frequencies. One technique used for maintaining unity gain in the oscillator circuit at all operating frequencies is to have a dynamic resistance, variable with changes in gain, in the negative feedback network. In the Model 209A this is accomplished with the combination of the peak comparator and AGC circuits.

4-11. The peak comparator compares the negative peak of the oscillator amplifier output to a 7.2 volt reference. If the output varies above or below the reference voltage, a difference voltage will be supplied to the AGC circuit. The "dynamic resistance" of the AGC circuit is a field-effect transistor with the gate controlled by the difference signal from the peak comparator. The oscillator amplifier output is held to 7.2 volts peak amplitude.

4-12. When the oscillator is first turned on, the AGC gives the amplifier a gain of much greater than three. Noise in the amplifier is amplified greatly, and the frequency selective network in the Wien bridge selects the noise at the tuned frequency. The selected noise becomes positive feedback to the amplifier, and the amplifier starts oscillating at the tuned frequency. As the output amplitude approaches 7.2 volts peak, the

AGC reduces the gain of the amplifier to three; and stable oscillation is achieved.

4-13. BUFFER AMPLIFIER.

4-14. The 5 volt rms sine wave output from the oscillator circuit is coupled to the buffer amplifier. The amplifier has a high open loop gain that is controlled by the negative feedback to provide a gain of 2. This enables the circuit to have very low distortion characteristics. The buffer amplifier uses a complementary symmetry transistor pair to furnish a 10 volt rms output.

4-15. SINE-SQUARE CONVERTER.

4-16. The 5 volt rms sine wave output from the oscillator circuit is also applied to the sine-square converter. The sine wave is coupled to a tunnel diode which produces a small square wave output with fast rise and fall times. This small square wave signal is then shaped and amplified. It appears at the output as a 20 volt peak-to-peak square wave.

4-17. DETAILED CIRCUIT DESCRIPTION.

4-18. For the following paragraphs, refer to the Oscillator Schematic Diagram, Figure 7-1.

4-19. Transistors A1Q1 through A1Q7 make up the basic oscillator amplifier. A1Q1 is an N-channel FET. A1CR1 sets up proper dc bias for A1Q2. Diodes A1CR6, A1CR7, A1CR8 set up proper bias for A1Q4. Capacitor A1C9 is chosen to provide a stable roll off at high frequencies. A1Q7 is a current source for A1Q3 and A1Q4. A1CR4 and A1CR5 provide proper biasing for complementary output transistors A1Q5 and A1Q6.

4-20. The positive feedback arm of the Wien bridge consists of tuning capacitors A1C1A and A1C1B, and range switching resistors A1R1 through A1R17.

4-21. The negative feedback arm of the Wien bridge depends upon the ratio of the impedance of A1R28 to the total impedance of A1R23, A1R24, A1R25, and A1Q8. A1R25 reduces the effect of the FET A1Q8 to increase stability. A1Q8 provides AGC for this amplifier by varying impedance to obtain the proper negative feedback.

4-22. The conduction of FET A1Q8 is controlled by the peak detector circuit using A1Q9. A1Q9 conducts during the most negative portion of each negative half cycle, developing a negative charge in A1C15 and its parallel capacitors. As the amplifier output amplitude increases, A1Q9 conducts more and A1C15 becomes more negatively charged. This makes the FET input voltage more negative, increasing its impedance and increasing the negative feedback to reduce the output amplitude of the amplifier.

4-23. Transistors A1Q13 through A1Q18 comprise a buffer amplifier with a gain of two. A1Q13 and A1Q14 form a differential amplifier. Diodes A1CR18 and A1CR19 furnish proper biasing for complementary output transistors A1Q17 and A1Q18. When the output attenuator A1R79 is fully clockwise, the output amplitude is greater than 10 volts rms. When the attenuator is fully counter-clockwise, the output is attenuated by greater than 20 dB.

4-24. The Sine-Square Converter circuit includes A1Q10 through A1Q12. This converter circuit operates as a saturating amplifier. Tunnel diode A1CR12 squares the sine wave input, and the Symmetry Adjust A1R45 determine the level where conduction starts. This provides for adjustment of the symmetry of the square wave. Zener diode A1CR15 sets the voltage level of the negative portion of the square wave. A1Q12 furnishes the positive portion of the square wave output, and A1Q11 furnishes the negative output.

4-25. POWER SUPPLY.

4-26. The following paragraphs refer to the Power Supply Schematic, Figure 7-2.

4-27. This power supply is a series regulated power supply furnishing +21 volts and -21 volts. Zener diode A2CR6 serves as a reference for the positive power supply, which in turn serves as the reference for the negative supply. The positive supply is described here, and the negative supply operates similarly.

4-28. Transistor A2Q1 regulates the output voltage and is controlled by A2Q3. A2Q2 is a current source for A2Q3. Zener diode A2CR5 furnishes bias for A2Q2, while A2R2 injects negative ripple feedback. A2CR6 sets the emitter voltage of A2Q3, setting up a reference for the supply output. A2Q4 current limits the output to prevent damage to the supply.

Table 5-1. Required Test Equipment

INSTRUMENT	REQUIRED SPECIFICATIONS	RECOMMENDED MODEL
Frequency Counter	Accuracy: +/-1 count Range: 4 Hz to 2 MHz	-hp- Model 5233L
AC Voltmeter	Range: 10 Hz to 2 MHz Sensitivity: 1 mV to 10 V Accuracy: +/-2%	-hp- Model 400E
DC Null Voltmeter	Sensitivity: 10 uV to 20 V Accuracy: +/-2% of full scale	-hp- Model 419A
Distortion Analyzer	Range: 5 Hz to 600 kHz Fundamental Rejection: greater than 60 dB	-hp- Model 334A
Test Oscillator	Range: 10 Hz to 2 MHz Output: 5 V rms open circuit	-hp- Model 651B
Oscilloscope	Frequency Range: 4 Hz to 20 MHz Sweep Speed: 50 nsec/cm	-hp- Model 140A (plug-ins) 1402A 1420A
Thermal Converter	Accuracy: +/-0.2% Frequency Range: 5 Hz to 2 MHz Voltage Input: 5 V rms Input Impedance: 600 ohms	-hp- Model H08-11049A
Bucking Supply	See Figure 5-2 for diagram a. R: fxd 6500 ohms b. R: var 500 ohms c. R: var 50 ohms d. Battery: 1.34 V	 -hp- Part No. 0811-0392 -hp- Part No. 2100-0324 -hp- Part No. 2100-1481 Mallory RM-42R
2 MHz Notch Filter	See Figure 5-3 for diagram a. C: fxd 30 pF b. C: fxd 400 pF (2) c. L: fxd 30 uH d. R: fxd 1 kilohm e. R: fxd 82 kilohms f. R: var 10 kilohms	 -hp- Part No. 0160-0181 -hp- Part No. 0150-0071 -hp- Part No. 9100-1624 -hp- Part No. 0686-1025 -hp- Part No. 0686-8235 -hp- Part No. 2100-1776
Balance Network	See Figure 5-4 for diagram a. R: fxd 300 ohms +/-0.1% b. R: fxd 150 ohms +/-1%	 -hp- Part No. 0811-0029 -hp- Part No. 0757-0715
Terminating Resistance	R: fxd 600 ohms +/-1%	-hp- Part No. 0757-1100
Capacitor	C: fxd 100 pF +/-10%	-hp- Part No. 0150-0073

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for the maintenance of the Model 209A Sine/Square Oscillator. Included are performance checks, adjustment and calibration procedures, and troubleshooting procedures.

5-3. The test equipment needed to properly maintain and service the Model 209A is listed in Table 5-1. If the recommended model is not available, other equipment may be substituted provided it meets the required specifications.

5-4. PERFORMANCE CHECKS.

5-5. The performance checks presented in this section are designed to compare the Model 209A with its published specifications. These checks can be used for incoming inspection, periodic maintenance checks, and to verify performance after adjustment or repair. A performance check test card appears at the end of this section which can be used to record the performance specifications.

5-6. DIAL ACCURACY CHECK.

a. Connect the Model 209A and the Frequency Counter as shown in Figure 5-1. Set the counter to measure frequency and check the Model 209A at the frequencies listed in Table 5-2 for the tolerances indicated.

b. If the above dial accuracy checks fail to meet the required specifications, refer to the Adjustment and Calibration Procedure in this section.

Table 5-2. Dial Accuracy Check

RANGE SWITCH	FREQUENCY DIAL	COUNTER INDICATION
X2	2	4 Hz +/-0.1 Hz
X2	5	10 Hz +/-0.3 Hz
X2	20	40 Hz +/-1.2 Hz
X10	2	20 Hz +/-0.6 Hz
X10	5	50 Hz +/-1.5 Hz
X10	20	200 Hz +/-6 Hz
X100	2	200 Hz +/-6 Hz
X100	5	500 Hz +/-15 Hz
X100	20	2 kHz +/-60 Hz
X1K	2	2 kHz +/-60 Hz
X1K	5	5 kHz +/-150 Hz
X1K	20	20 kHz +/-600 Hz
X10K	2	20 kHz +/-600 Hz
X10K	5	50 kHz +/-1.5 kHz
X10K	20	200 kHz +/-6 kHz
X100K	2	200 kHz +/-6 kHz
X100K	5	500 kHz +/-15 kHz
X100K	20	2 MHz +/-60 kHz

5-7. FLATNESS CHECK.

a. Connect the equipment as shown in Figure 5-2.

NOTE

The BUCKING SUPPLY should be constructed from the components listed in Table 5-1. The 500 ohm control should be used as a coarse adjust and the 50 ohm control should be used as a fine adjust.

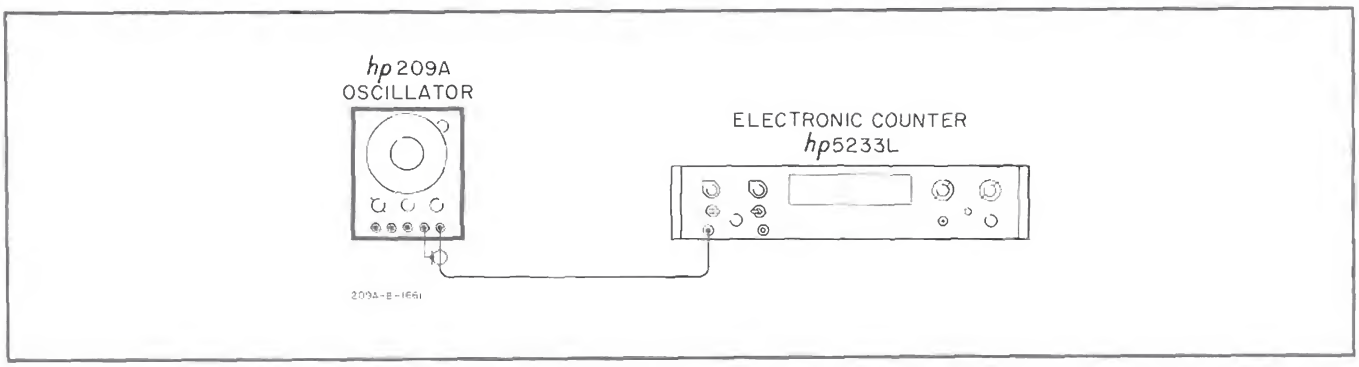


Figure 5-1. Dial Accuracy Check

PERFORMANCE CHECK TEST CARD (Cont'd)

DESCRIPTION	CHECK		
Distortion:			
Range / Dial	NORM		LOW DIST
X2 2.5	-40 dB _____		-54 dB _____
X2 10	-40 dB _____		-54 dB _____
X10 2	-40 dB _____		-54 dB _____
X10 10		-54 dB _____	
X100 2		-60 dB _____	
X100 10		-60 dB _____	
X1K 2		-60 dB _____	
X1K 10		-60 dB _____	
X10K 2		-60 dB _____	
X10K 10		-60 dB _____	
X100K 2		-60 dB _____	
X100K 6		-50 dB _____	
X100K 20		-40 dB _____	
Output Voltage and Impedance (Sine Wave):			
No load		10 V rms _____	
600 ohm load		5 V rms _____	
Output Control (Sine Wave):		<1 V rms _____	
Balance (Sine Wave):		-40 dB _____	
Output Voltage (Square Wave):		20 V pk-pk _____	
Rise and Fall Time (Square Wave):		50 nsec _____	
Symmetry (Square Wave):		+/-0.5 cm _____	
Sync Output:		1.7 V rms _____	
Sync Input:	<18.6 kHz	_____	>21.4 kHz

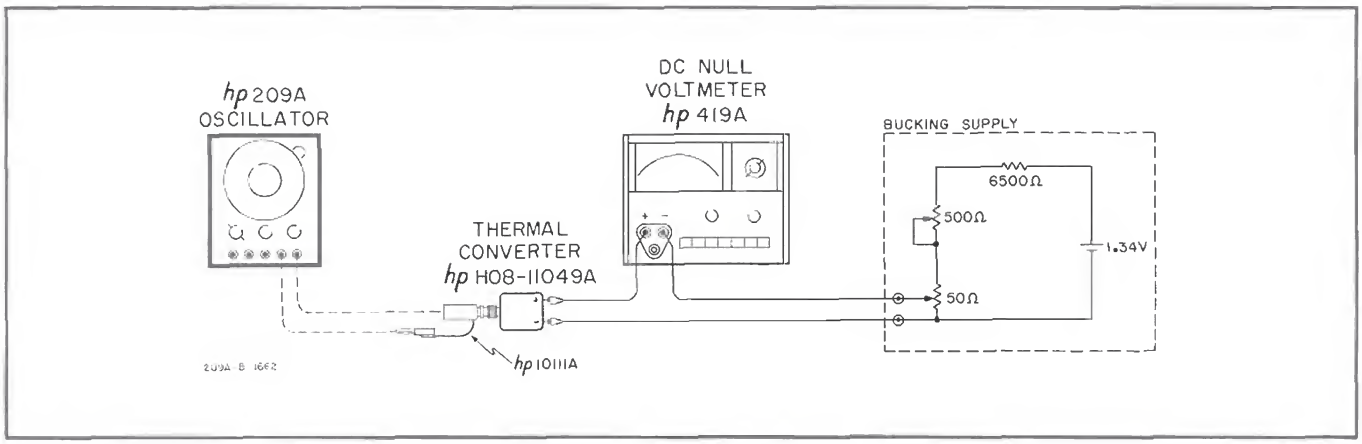


Figure 5-2. Flatness Check

b. Set the Model 209A RANGE switch to X100 and the frequency dial to 10. Set the AMPLITUDE control to maximum output.

c. Adjust the BUCKING SUPPLY 50 ohm fine control for minimum resistance, and record the THERMAL CONVERTER output as indicated on the DC NULL VOLTMETER.

d. Adjust the BUCKING SUPPLY coarse and fine controls for a 0V indication on the DC NULL VOLTMETER. Do not readjust the BUCKING SUPPLY controls for the remainder of this check.

e. Check the Model 209A flatness at the frequencies listed in Table 5-3, recording the DC NULL VOLTMETER indication for each frequency.

NOTE

The THERMAL CONVERTER is considered a square-law device. Therefore, theoretically, the percent of change at the output of the THERMAL CONVERTER should be 2 times the percent of change at the input. Actually the value is not quite 2. The number is typically 1.7. The multiplier (M) can be determined by measuring the output (Ei) for a given input, doubling the input and again measuring the output (EF). The multiplier is then determined by the following formula:

$$M = EF/2Ei$$

f. Convert each reading on the DC NULL VOLTMETER to the percentages listed in Table 5-3 by the following procedure. Divide the DC NULL VOLTMETER indication by the THERMAL CONVERTER output voltage recorded in step c of this paragraph. Multiply this value by 100 to get percent of output change. Divide this percentage by the THERMAL CONVERTER multiplier to obtain a percentage within the tolerances listed in Table 5-3.

Example:

Frequency	100 kHz
THERMAL CONVERTER output	5 mV
DC NULL VOLTMETER reading	25 uV
Calibration Report multiplier	1.7
Table 5-3 tolerance	+/-0.5%

$$\frac{.025 \text{ mV} \times 100\%}{5 \text{ mV} \times 1.7} = 0.29\%$$

Table 5-3. Flatness Check

Frequency		Tolerance	
Dial Setting	RANGE Setting	NORM	LOW DIST.
2.5	X2	+5% - 1%	+/-1%
10	X2	+5% - 1%	+/-1%
2.5	X10	+5% - 1%	+/-1%
10	X10	+/-0.5%	
2.5	X100	+/-0.5%	
10	X100	SET	
2.5	X1K	+/-0.5%	
10	X1K	+/-0.5%	
2.5	X10K	+/-0.5%	
10	X10K	+/-0.5%	
3	X100K	+/-0.5%	
10	X100K	+/-1%	
20	X100K	+/-5%	

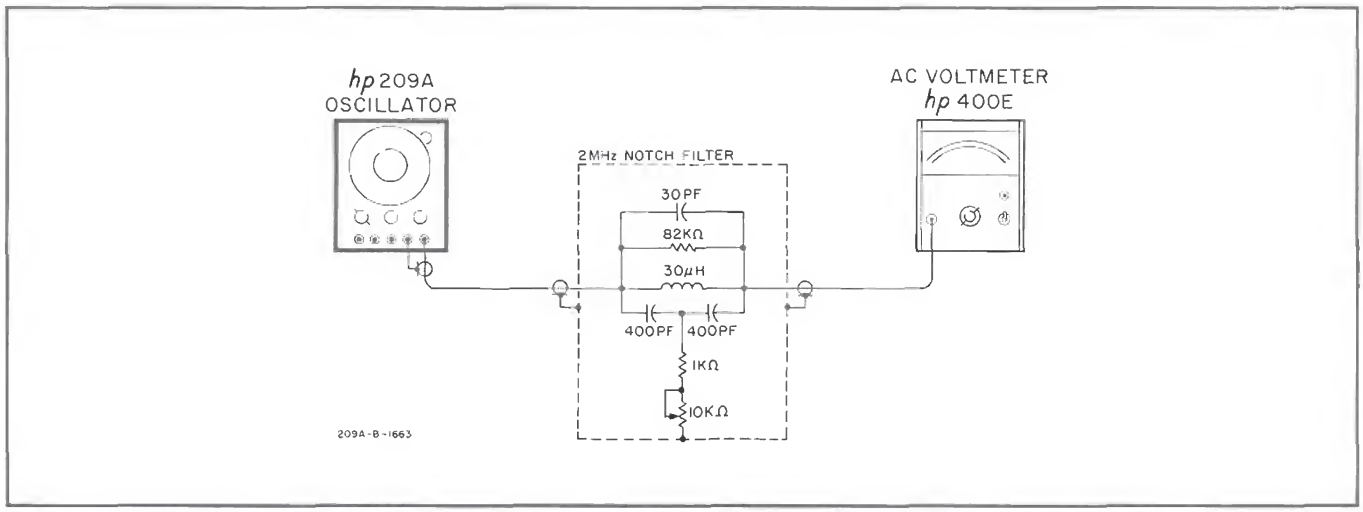


Figure 5-3. 2 MHz Distortion Check

5-8. DISTORTION CHECK.

a. Connect the Model 209A sine wave output with a 600 ohm load to the Distortion Analyzer.

b. Set the Model 209A controls as follows:

Dial 10
RANGE X100
Amplitude ..... Full CW
NORM/LOW DIST ..... NORM

c. Set the Distortion Analyzer controls as follows:

Dial 10
FREQUENCY RANGE X100
METER RANGE .....0 dB
FUNCTION .....SET LEVEL
SENSITIVITY ..... MIN
MODE .....MANUAL

d. Increase the Distortion Analyzer SENSITIVITY to obtain a 0 dB indication on the meter.

e. Switch the Distortion Analyzer FUNCTION to DISTORTION, and adjust the Distortion Analyzer dial and BALANCE controls for a null indication on the meter.

f. When an approximate null has been obtained with the Distortion Analyzer dial and BALANCE controls, switch the MODE to AUTOMATIC for minimum meter indication.

g. Meter indication should be greater than 60 dB down from the 0 dB reference.

h. Repeat steps a through f of this paragraph for all frequencies listed in Table 5-4.

i. Connect the equipment as shown in Figure 5-3.

j. Set the Model 209A frequency dial to 20 and the RANGE switch to X1K. Adjust the sine wave amplitude control for a 0 dB indication on the AC Voltmeter.

k. Switch to the X100K RANGE, and adjust the frequency dial and notch filter control for a minimum indication on the AC Voltmeter.

l. The meter indication should be greater than 40 dB down from the 0 dB reference.

Table 5-4. Distortion Check

Frequency		Tolerance	
Dial Setting	RANGE Setting	NORM	LOW DIST.
2.5	X2	-40 dB	-54 dB
10	X2	-40 dB	-54 dB
2	X10	-40 dB	-54 dB
10	X10	-54 dB	
2	X100	-60 dB	
10	X100	-60 dB	
2	X1K	-60 dB	
10	X1K	-60 dB	
2	X10K	-60 dB	
10	X10K	-60 dB	
2	X100K	-60 dB	
6	X100K	-50 dB	

5-9. OUTPUT VOLTAGE AND IMPEDANCE CHECK (SINE WAVE).

a. Connect the Model 209A sine wave output without a 600 ohm load to the AC Voltmeter.

b. Set the AC Voltmeter to the 10V RANGE, and the Model 209A sine wave amplitude to maximum at a frequency setting of 20 kHz.

c. The meter should indicate at least 10 V rms.

d. Reduce the 209A output to 10 V rms.

e. Connect a 600 ohm load to the Model 209A.

f. The AC Voltmeter should indicate 5 volts rms, verifying the output voltage specification and an approximate output impedance of 600 ohms.

5-10. OUTPUT CONTROL CHECK (SINE WAVE).

a. Connect the Model 209A sine wave output without a 600 ohm load to the AC Voltmeter.

b. Adjust the Model 209A sine wave amplitude to minimum.

c. The meter indication should be less than 1 volt rms.

5-11. BALANCE CHECK (SINE WAVE).

a. Connect the Model 209A sine wave output with a 600 ohm load to the AC Voltmeter.

b. Set controls as follows:

Model 209A:
Dial 2
RANGE X10K

AC Voltmeter:
RANGE ..... .0 DB

c. Adjust the Model 209A sine wave amplitude for a meter indication of 0 dB.

d. Remove the 600 ohm load and connect the equipment as shown in Figure 5-4.

e. Meter indication should be greater than 40 dB down from 0 dB reference.

5-12. OUTPUT VOLTAGE CHECK (SQUARE WAVE).

a. Set the Model 209A frequency to 20 kHz, and the square wave amplitude to maximum.

b. Connect the Model 209A square wave output to the vertical input on the oscilloscope, using a low capacitance 10:1 divider probe.

c. The square wave viewed on the oscilloscope should have an amplitude of at least 20 volts peak-to-peak.

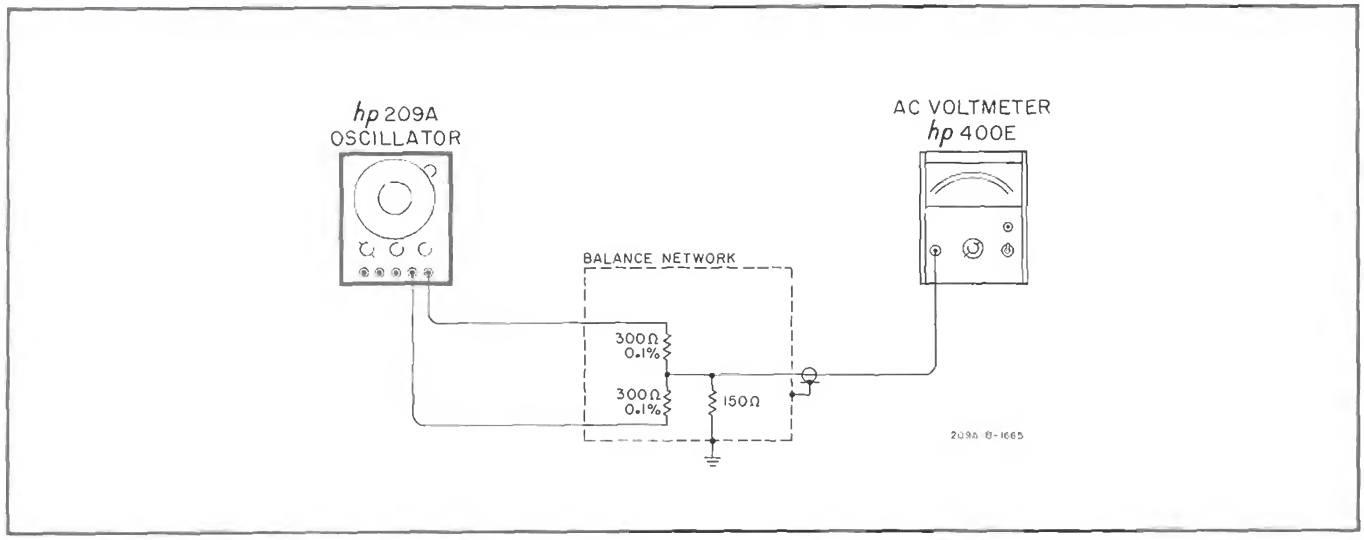


Figure 5-4. Balance Check

5-13. RISE TIME CHECK (SQUARE WAVE).

a. With the square wave output still connected to the oscilloscope with the 10:1 divider probe, set the Model 209A frequency to 2 MHz and the oscilloscope sweep time to 50 nsec/cm.

b. Observe the rise and fall skirts of the waveform. The 10% to 90% amplitude points of the waveform should be no wider than 1 cm (50 nsec).

5-14. SYMMETRY CHECK (SQUARE WAVE).

a. With the square wave output still connected to the oscilloscope with the 10:1 divider probe, set the Model 209A frequency to 200 kHz and the oscilloscope sweep time to 0.5 usec/cm.

b. While observing the waveform on the oscilloscope, adjust the Model 209A frequency dial for exactly 1 cycle for 10 centimeters.

c. The waveform crossover point should be within +/-0.5 cm of the center of the oscilloscope graticule.

5-15. SYNC OUTPUT CHECK.

a. Connect a 100 pF capacitor across the Model 209A SYNC output.

b. Connect the Model 209A SYNC output to the AC Voltmeter, using a low capacitance 10:1 divider probe.

c. The SYNC output should be at least 1.7 V rms at 50 kHz, at least 0.1 V at 2 MHz.

5-16. SYNC INPUT CHECK.

a. Connect the Test Oscillator to the AC Voltmeter and adjust the controls for 5 V rms at 20 kHz.

b. Connect the Model 209A sine wave output to the Electronic Counter and adjust controls for a frequency of 20 kHz.

c. Without changing the controls set in steps a and b, connect the equipment as shown in Figure 5-5.

d. Adjust the oscilloscope to synchronize externally on the Test Oscillator signal.

e. Rotate the Test Oscillator dial above and below 20 kHz while watching the indication on the oscilloscope. When the waveform begins to lose synchronization, note the frequency indication on the Electronic Counter.

f. The waveform should remain synchronized to less than 18.6 kHz and greater than 21.4 kHz, indicating a sync range of +/-7% at 5 V rms.

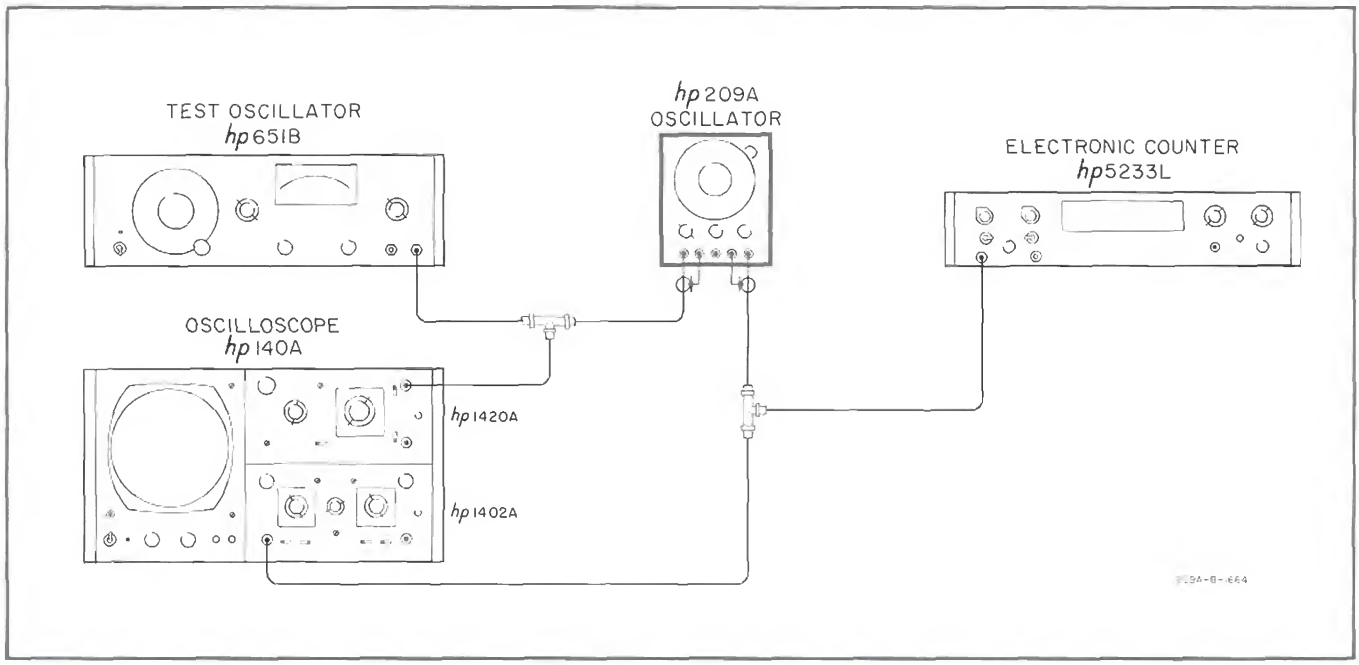


Figure 5-5. Sync Input Check

5-17. COVER REMOVAL.

5-18. To perform the Adjustment and Calibration Procedure, it is necessary to remove the two side covers, each of which is held in place by four screws.

CAUTION

USE ONLY THE SCREWS REMOVED OR ONES OF EQUAL LENGTH WHEN REINSTALLING SIDE PANELS. LONGER SCREWS MAY DAMAGE THE POWER SUPPLY BOARD IF FORCED IN.

5-19. To perform internal troubleshooting or repair procedures, the side covers and top and bottom covers must be removed. Remove the two front and two rear screws in each side casting and remove the side castings.

NOTE

Do not remove any screws on the rear panel.

Remove the rear panel, pulling out the bottom edge first. Remove one screw from the top and each side of the chassis shield and slide the chassis off.

5-20. To operate the 209A with the chassis shield removed, connect the power supply in the rear panel to the pc board.

NOTE

To operate the instrument with shield removed, the jumper must be connected as explained below.

Connect a *short* clip lead between the chassis section on which the tuning capacitor is mounted and the sheet metal tab immediately below it containing the tapped screw hole.

5-21. The chassis shield should be in place when doing the Performance Checks.

5-22. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-23. INTRODUCTION.

5-24. The following Adjustment and Calibration Procedures should be used only if it has been determined through the Performance Checks that the Model 209A is not performing within its specifications.

5-25. If proper performance cannot be achieved with the Adjustment and Calibration Procedure, refer to the Troubleshooting Procedures.

5-26. POWER SUPPLY.

5-27. Before making any adjustments, check the power supply voltages at test points 2 and 3. These test points may be reached through the shield cut-out labeled B+ and B-. They should indicate +21V and -21V respectively, with reference to the shield. If the voltages are off greater than +/-1 V, troubleshoot the power supply.

5-28. BIAS ADJUSTMENT.

a. Set the Model 209A Range Switch to X1K.

b. Connect the DC Voltmeter to TP4 (BIAS).

c. Adjust R20 (BIAS) for 0 V indication on the meter.

5-29. AGC ADJUSTMENT.

a. Set the Model 209A RANGE switch to X1K and the Dial to 2.

b. Connect the DC Voltmeter to TP1 (AGC).

c. Adjust R24 (AGC) for -2.0 V at TP1.

5-30. AGC AND FREQUENCY ADJUSTMENT.

a. Leave the DC Voltmeter connected as in Paragraph 5-29, and connect the Model 209A sine wave output to the Frequency Counter.

b. Set the Model 209A RANGE to X1K and the Dial to 20.

c. Adjust C3 and C8 (AGC and FREQ CAL) for 20 kHz and -2.0 V, respectively.

NOTE

C3 and C8 are interacting controls. Make one half the apparent needed correction in each adjustment. Several adjustments will be necessary.

d. Repeat Paragraphs 5-29 and 5-30 a through c if the voltage at 2 kHz has changed from -2.0 V.

e. With the RANGE switch set on X1K, adjust the Dial for 20 kHz +/-20 Hz on the counter.

f. Without moving the Dial, check the frequency on ranges X2 through X10K and record the error in percent.

g. Calculate the average between the most positive and the most negative error.

h. Readjust C2 and C8 for the following readings on the X1K range:

Frequency .....20 kHz minus average found above +/-20 Hz
AGC .....-2.0 V +/-0.1 V

Example:

X2	+5%
X10	+1%
X100	-1%
X1K	0
X10K	+2%

Most positive error +5%
Most negative error -1%
Average error $\frac{(+5\%) + (-1\%)}{2} = +2\%$

Adjust frequency for 19,600 Hz +/-20 Hz.

5-31. HIGH FREQUENCY ADJUSTMENT.

a. Set the Model 209A RANGE switch to X100K and set the Dial to exactly 20.

b. With the Model 209A sine wave output connected to the Frequency Counter, adjust C5 (HIGH FREQ CAL) to indicate 2 MHz +/-2 kHz on the Frequency Counter.

5-32. DISTORTION ADJUSTMENT.

a. Connect the Model 209A sine wave output to the Distortion Analyzer.

b. Set the Model 209A RANGE switch to X1K and the Dial to 20.

c. Set the Distortion Analyzer FUNCTION to SET LEVEL, MODE to MANUAL, and FREQUENCY RANGE to X1K.

d. Adjust the Model 209A sine wave amplitude and Distortion Analyzer SENSITIVITY for 0 dB meter indication.

e. Set the Distortion Analyzer Dial and Balance controls for minimum indication.

f. Set the Distortion Analyzer MODE to AUTOMATIC and adjust R30 (DIST) for a meter indication of greater than 60 dB down from 0 dB reference.

5-33. SYMMETRY ADJUSTMENT.

a. Connect the Model 209A square wave output to the oscilloscope.

b. Set the Model 209A frequency to 200 kHz and the oscilloscope sweep speed to 0.5 usec/cm.

c. Set the Model 209A frequency dial for exactly 1 cycle of square wave per 10 centimeters on the oscilloscope.

d. Adjust the symmetry adjust, R45, for a symmetrical square wave.

5-34. FACTORY SELECTED COMPONENTS.

5-35. Table 5-5 shows the components that are factory selected, and how to select the component.

Table 5-5. Factory Selected Components

Component	Selection
A1C4	Use smaller value to increase amplifier bandwidth.
A1C9	Use larger value if high frequency oscillations occur at lower frequencies.
A1R7,9,15,17	Chosen for proper oscillator frequencies.
A1R36	Use larger or smaller value to suppress parasitic oscillations.
A1R82,83	Use larger value to suppress parasitic oscillation near 2 MHz.

5-36. TROUBLESHOOTING PROCEDURES.

5-37. FRONT PANEL PROCEDURE.

5-38. Use an oscilloscope to monitor the following checks. Record the results of each step for reference.

a. Set the Model 209A frequency to 2 x 100K, turn the sine wave amplitude fully CW, and check for a sine wave output. If the sine wave is clipped, record this.

b. Check the sine wave output on each range.

c. Check for a 4.8 V p-p sine wave sync output at 1 kHz.

d. Check for a 20 V p-p square wave output, symmetrical around 0 V.

5-39. Compare the results of the preceding steps to Table 5-6 to help locate the trouble.

5-40. DETAILED CIRCUIT TROUBLESHOOTING.

5-41. The Oscillator Schematic Diagram, Figure 7-1, shows dc voltages normally found throughout the instrument. These voltages were taken with the AGC ADJUST R24 turned fully CCW. This disables the oscillator. The voltages were taken with a battery operated dc voltmeter, -hp- Model 427A. When making these measurements, be sure to connect the jumper between the chassis section where the tuning capacitor is mounted and the tab just below it.

5-42. The Oscillator Amplifier may be disabled by turning AGC ADJUST R24 fully counter-clockwise. A one volt rms sine wave from an external source may now be injected into the gate of A1Q1. The various stages of the amplifier may now be monitored with an oscilloscope for proper operation. The amplifier should have a gain of three for all frequencies up to 100 kHz.

5-43. For detailed circuit theory of operation, refer to Section IV of this manual.

Table 5-6. Front Panel Symptoms

Sine Wave Output	Sync Output	Square Wave Output	Action Required
Normal	Normal	Normal	Do Performance Checks
Clipped	Normal	Low Amplitude	Troubleshoot Power Supply
Clipped or Missing	Normal	Normal	Troubleshoot Buffer Amplifier
Normal	Normal	Abnormal	Troubleshoot Sine-Square Converter
No Output	No Output	No Output	Troubleshoot Oscillator Amplifier
All outputs abnormal on one or more ranges			Troubleshoot Range Switch Assembly and Negative Feedback Circuit

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 209A
Sine/Square Oscillator
Serial No. _____

Test Performed By _____

Date _____

DESCRIPTION		CHECK	
Dial Accuracy:		Tolerance:	
Range	Dial		
X2	2	4 Hz _____	+/-0.1 Hz _____
X2	5	10 Hz _____	+/-0.3 Hz _____
X2	20	40 Hz _____	+/-1.2 Hz _____
X10	2	20 Hz _____	+/-0.6 Hz _____
X10	5	50 Hz _____	+/-1.5 Hz _____
X10	20	200 Hz _____	+/-6 Hz _____
X100	2	200 Hz _____	+/-6 Hz _____
X100	5	500 Hz _____	+/-15 Hz _____
X100	20	2 kHz _____	+/-60 Hz _____
X1K	2	2 kHz _____	+/-60 Hz _____
X1K	5	5 kHz _____	+/-150 Hz _____
X1K	20	20 kHz _____	+/-600 Hz _____
X10K	2	20 kHz _____	+/-600 Hz _____
X10K	5	50 kHz _____	+/-1.5 kHz _____
X10K	20	200 kHz _____	+/-6 kHz _____
X100K	2	200 kHz _____	+/-6 kHz _____
X100K	5	500 kHz _____	+/-15 kHz _____
X100K	20	2 MHz _____	+/-60 kHz _____
Flatness:		Tolerance:	
Range	Dial	NORM	LOW DIST
X2	2.5	+5% -1% _____	+/-1% _____
X2	10	+5% -1% _____	+/-1% _____
X10	2.5	+5% -1% _____	+/-1% _____
X10	10	+/-0.5% _____	
X100	2.5	+/-0.5% _____	
X100	10	SET _____	
X1K	2.5	+/-0.5% _____	
X1K	10	+/-0.5% _____	
X10K	2.5	+/-0.5% _____	
X10K	10	+/-0.5% _____	
X100K	3	+/-0.5% _____	
X100K	10	+/-1% _____	
X100K	20	+/-5% _____	

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Descriptions of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix for list of manufacturers.) Parts that are manufactured by Hewlett-Packard are identified by the abbreviation -hp-.

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	MP	= mechanical part	TC	= thermocouple
B	= motor	FL	= filter	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
BT	= battery	HR	= heater	Q	= transistor		
C	= capacitor	IC	= integrated circuit	QCR	= transistor-diode	W	= cable
CR	= diode	J	= jack	R	= resistor	X	= socket
DL	= delay line	K	= relay	RT	= thermistor	XDS	= lampholder
DS	= lamp	L	= inductor	S	= switch	XF	= fuseholder
E	= misc electronic part	M	= meter	T	= transformer	Z	= network

ABBREVIATIONS

Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9} seconds	sl	= slide
Al	= aluminum	impg	= impregnated			SPDT	= single-pole double-throw
A	= ampere (s)	incd	= incandescent	nsr	= not separately replaceable	SPST	= single-pole single-throw
Au	= gold	ins	= insulation (ed)				
C	= capacitor	kΩ	= kilohm (s) = 10^{+3} ohms	Ω	= ohm (s)	Ta	= tantalum
cer	= ceramic	kHz	= kilohertz = 10^{+3} hertz	obd	= order by description	TC	= temperature coefficient
coef	= coefficient			OD	= outside diameter	TiO_2	= titanium dioxide
com	= common	L	= inductor				
comp	= composition	lin	= linear taper	p	= peak	tog	= toggle
conn	= connection	log	= logarithmic taper	pc	= printed circuit	tol	= tolerance
dep	= deposited	m	= milli = 10^{-3}	pF	= picofarad (s) = 10^{-12} farads	trim	= trimmer
DPDT	= double-pole double-throw	mA	= milliampere (s) = 10^{-3} amperes	piv	= peak inverse voltage	TSTR	= transistor
DPST	= double-pole single-throw	MHz	= megahertz = 10^{+6} hertz	p/o	= part of	V	= volt (s)
elect	= electrolytic	MΩ	= megohm (s) = 10^{+6} ohms	pos	= position (s)	vacw	= alternating current working voltage
encap	= encapsulated	met flm	= metal film	poly	= polystyrene	var	= variable
F	= farad (s)	mfr	= manufacturer	pot	= potentiometer	vdcw	= direct current working voltage
FET	= field effect transistor	mtg	= mounting	p-p	= peak-to-peak		
fxd	= fixed	mV	= millivolt (s) = 10^{-3} volts	ppm	= parts per million	W	= watt (s)
GaAs	= gallium arsenide	μ	= micro = 10^{-6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance)	w/	= with
GHz	= gigahertz = 10^{+9} hertz	μV	= microvolt (s) = 10^{-6} volts			wiv	= working inverse voltage
gd	= guard (ed)	my	= Mylar ®			w/o	= without
Ge	= germanium	nA	= nanoampere (s) = 10^{-9} amperes	R	= resistor	ww	= wirewound
grd	= ground (ed)	NC	= normally closed	Rh	= rhodium	*	= optimum value selected at factory, average value shown (part may be omitted)
H	= henry (ies)	Ne	= neon	rms	= root-mean-square		
Hg	= mercury	NO	= normally open	rot	= rotary	**	= no standard type number assigned (selected or special type)
Hz	= hertz (cycle (s) per second)	NPO	= negative positive zero (zero temperature coefficient)	Se	= selenium		
				sect	= section (s)		
				Si	= silicon		

stvs

® Dupont de Nemours

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
				A1 OSCILLATOR ASSEMBLY		
A1	00209-66501		1	Assembly: PC Board	-hp-	
C1	0150-0093		1	C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
C2				Not assigned		
C3	0121-0105		1	C: var cer 9 -35 pF	72982	538-006 94D
C4*	0150-0043		1	C: fxd TiO_2 6.8 pF +/-5% 500 vdcw	78488	Type GA obd
C5	0121-0105			C: var cer 9 - 35 pF	72982	538-006 94D
C6	0150-0031		1	C: fxd TiO_2 2 pF +/-5% 500 vdcw	78488	Type GA obd
C7	0180-0197		4	C: fxd Ta elect 2.2 uF +/-10% 20 vdcw	56289	150D225X9020A2-DYS
C8	0121-0036		1	C: var cer 5.5 -18 pF	72982	538-006 COPO 92R
C9*	0150-0011		2	C: fxd TiO_2 1.5 pF +/-20% 500 vdcw	78488	Type GA obd
C10				Not assigned		
C11, C12	0180-0393		1	C: fxd Ta elect 39 uF +/-10% 10 vdcw	56289	150D396X9010B2-DYS
C13	0180-0355		1	C: fxd Ta elect 3.4 uF +/-20% 35 vdcw	56289	151D345X0035X2
C14	0180-0197			C: fxd Ta elect 2.2 uF +/-10% 20 vdcw	56289	150D225X9020A2-DYS
C15	0160-3077		1	C: fxd my 0.027 uF +/-10% 100 vdcw	56289	225P27391WB1-PWM
C16	0180-0228		1	C: fxd Ta elect 22 uF +/-10% 15 vdcw	56289	150D226X9015B2-DYS
C17	0180-0393			C: fxd Ta elect 39 uF +/-10% 10 vdcw	56289	150D396X9010B2-DYS
C18	0180-0197			C: fxd Ta elect 2.2 uF +/-10% 20 vdcw	56289	150D225X9020A2-DYS
C19	0180-0039		1	C: fxd Al elect 100 uF +75% -10% 12 vdcw	56289	30D107G012CC2-DSM
C20	0180-0197			C: fxd Ta elect 2.2 uF +/-10% 20 vdcw	56289	150D225X9020A2-DYS
C21	0180-0228			C: fxd Ta elect 22 uF +/-10% 15 vdcw	56289	150D226X9015B2-DYS
C22	0160-0763		1	C: fxd mica 5 pF +/-10%	72136	RDM15C050K5S
C23	0140-0197		1	C: fxd mica 180 pF +/-5% 500 vdcw	72136	RDM15F181J3C
C24, C25	0180-0116			C: fxd Ta elect 6.8 uF +/-10% 35 vdcw	56289	150D685X9035B2-DYS
C26	0180-0039			C: fxd Al elect 100 uF +75% -10% 12 vdcw	56289	30D107G012CC2-DSM
C27	0150-0121		1	C: fxd cer 0.1 uF +80% -20% 50 vdcw	56289	5C50B1-CML
C28	0150-0093			C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
C29	0180-0140		1	C: fxd Al elect 300 uF +100% -10% 10 vdcw	56289	D36546
C30*	0150-0011			C: fxd TiO_2 1.5 pF +/-20% 500 vdcw	78488	Type GA obd
CR1	1902-0041		2	Diode: breakdown zener 5.1 V +/-5%	04713	SZ10939-98
CR2 thru CR5	1901-0040		13	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
CR6	1902-0041			Diode. breakdown zener 5.1 V +/-5%	04713	SZ10939-98
CR7, CR8	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
CR9	1901-0347		1	Diode: Si hot carrier 8V 20 mA at +1.15 pF 120 ps	-hp-	
CR10	1902-0057		1	Diode: zener 6.49 V +/-5%	04713	SZ10939-128
CR11	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
CR12	1912-0009		1	Diode: tunnel	01002	
CR13	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
CR14	1910-0016		1	Diode: Ge 60 wiv 1 ms	03877	S3185G
CR15	1902-3150		2	Diode: breakdown zener 9.09 V +/-2%	04713	SZ10939-171
CR16 thru CR20	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
L1				Not assigned		
L2	9100-1636		1	Coil: molded choke 110 uH +/-5%	82142	15-1315-13J
L3	9100-1618		1	Coil: molded choke 5.60 uH +/-10%	82142	15-4435-1K
Q1	1855-0318		1	TSTR: Si FET-N-Channel	04713	SS 3740
Q2	1853-0010		10	TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q3	1854-0092		1	TSTR: Si NPN 2N3563	04713	MPS 3563
Q5	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q4,Q6	1854-0215		8	TSTR: Si NPN 2N3904	04713	SPS-3611
Q7	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q8	1855-0089		1	TSTR: Si FET-N-Channel	04713	SS 3740
Q9, Q10	1853-0010			TSRT: Si PNP 360 mW 30 V	04713	SM4713
Q11	1854-0094		1	TSTR: Si NPN 2N3646	07263	obd
Q12 thru Q14	1854-0215			TSTR: Si NPN 2N3904	04713	SPS-3611
Q15	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q16, Q17	1854-0215			TSTR: Si NPN 2N3904	04713	SPS-3611
Q18	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
R1	0683-4715		1	R: fxd comp 470 ohms +/-5% 1/4 W	01121	CB 4715
R2	0689-6706		1	R: fxd met film 1.24 kilohms +/-1/4% 1/8 W	75042	CEA T-0 obd
R3	0698-6707		1	R: fxd met film 12.4 kilohms +/-1/4% 1/8 W	75042	CEA T-0 obd
R4	0698-6722		1	R: fxd met film 124 kilohms +/-0.1% 1/8 W	75042	CEA T-2 obd
R5	0698-6702		2	R: fxd met film 1.24 megohm +/-1/4% 1/2 W	75042	CEC T-0 obd
R6	0698-6711		2	R: fxd met film 12 megohm +/-1% 1/2 W	00327	M12 obd
R7*	0683-4745		2	R: fxd comp 470 kilohms +/-5% 1/4 W	01121	CB 4745
R8	0698-6712		2	R: fxd met film 47.5 megohm +/-1% 1 W	00327	M13 obd
R9*	0698-6710		2	R: fxd met film 14.50 megohm +/-1% 1/2 W	00327	M12 obd
R10	0698-6706			R: fxd met film 1.24 kilohms +/-1/4% 1/8 W	75042	CEA T-0 obd
R11	0698-6707			R: fxd met film 12.4 kilohms +/-1/4% 1/8 W	75042	CEA T-0 obd
R12	0698-6722			R: fxd met film 124 kilohms +/-0.1% 1/8 W	75042	CEA T-2 obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
R13	0698-6702			R: fxd met flm 1.24 megohm +/-1/4% 1/2 W	75042	CEC T-O obd
R14	0698-6711			R: fxd met flm 12 megohm +/-1% 1/2 W	00327	M12 obd
R15*	0683-4745			R: fxd comp 470 kilohm +/-5% 1/4 W	01121	CB 4745
R16	0698-6712			R: fxd met flm 47.5 megohm +/-1% 1 W	00327	M13 obd
R17*	0698-6710			R: fxd met flm 14.50 megohm +/-1% 1/2 W	00327	M12 obd
R18	0757-0465		1	R: fxd met flm 100 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R19	0698-4504		1	R: fxd met flm 69.8 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R20	2100-2640		1	R: var Type V 3 section 50 kilohms	71590	Type 70-3
R21	0757-0280		1	R: fxd met flm 1 kilohm +/-1% 1/8 W	75042	CEA T-O obd
R22	0683-4715			R: fxd comp 470 ohms +/-5% 1/4 W	01121	CB 4715
R23	0698-4408		1	R: fxd met flm 124 ohms +/-1% 1/8 W	91637	MFF-1/8 T-1
R24	2100-2640			R: var Type V 3 section 250 ohms	71590	Type 70-3
R25	0698-4411		1	R: fxd met flm 140 ohms +/-1% 1/8 W	91637	MFF-1/8 T-1
R26	0757-0433		1	R: fxd met flm 3.32 kilohm +/-1% 1/8 W	75042	CEA T-O obd
R27	0684-1831		1	R: fxd comp 18 kilohm +/-10% 1/4 W	01121	CB 1831
R28	0698-4456		1	R: fxd met flm 549 ohms +/-1% 1/8 W	75042	CEA T-O obd
R29	0684-1031		2	R: fxd comp 10 kilohms +/-10% 1/4 W	01121	CB 1031
R30	2100-2640			R: var Type V 3 section 50 kilohms	71590	Type 70-3
R31	0757-0453		1	R: fxd met flm 30.1 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R32	0757-0457		1	R: fxd met flm 47.5 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R33	0684-1831			R: fxd comp 18 kilohms +/-10% 1/4 W	01121	CB 1831
R34	0684-6811		1	R: fxd comp 680 ohms +/-10% 1/4 W	01121	CB 6811
R35	0684-1831			R: fxd comp 18 kilohms +/-10% 1/4 W	01121	CB 1831
R36*	0684-0271		1	R: fxd comp 2.7 ohms +/-10% 1/4 W	01121	CB 27G1
R37	0684-1041		1	R: fxd comp 100 kilohms +/-10% 1/4 W	01121	CB 1041
R38	0698-4451		1	R: fxd met flm 340 ohms +/-1% 1/8 W	75042	CEA T-O obd
R39	0698-4411			R: fxd met flm 140 ohms +/-1% 1/8 W	91637	MFF-1/8 T-1
R40	0684-1831			R: fxd comp 18 kilohms +/-10% 1/4 W	01121	CB 1831
R41, R42	0684-2201		1	R: fxd comp 22 ohms +/-10% 1/4 W	01121	CB 2201
R43	0684-1031			R: fxd comp 10 kilohms +/-10% 1/4 W	01121	CB 1031
R44	0757-0401		1	R: fxd met flm 100 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R45	2100-2550		1	R: var comp lin trim 20 kilohms +/-30%	71450	XPE 200RE
R46	0757-0453			R: fxd met flm 30.1 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R47	0684-4721		1	R: fxd comp 4700 ohms +/-10% 1/4 W	01121	CB 472
R48	0698-3519		1	R: fxd met flm 12.4 kilohms +/-1% 1/8 W	19701	MF5C T-O obd
R49	0757-0441		1	R: fxd met flm 8250 ohms +/-1% 1/8 W	75042	CEA T-O obd
R50	0757-0278		1	R: fxd met flm 1780 ohms +/-1% 1/8 W	75042	CEA T-O obd
R51	0698-4433		1	R: fxd met flm 2.26 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R52, R53	0684-8201		2	R: fxd comp 82 ohms +/-10% 1/4 W	01121	CB 8201
R54	0757-0283		1	R: fxd met flm 2000 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R55	0684-1821		1	R: fxd comp 1800 ohms +/-10% 1/4 W	01121	CB 1821
R56	0757-0278			R: fxd met flm 1780 ohms +/-1% 1/8 W	75042	CEA T-O obd
R57	0684-4701		3	R: fxd comp 47 ohms +/-10% 1/4 W	01121	CB 4701
R58				Not assigned		
R59	2100-2586		1	R: var comp lin 1000 ohms +/-20% 2 W	01121	Type J
R60	0683-4715			R: fxd comp 470 ohms +/-10% 1/4 W	01121	CB 1811
R61, R62	0757-0442		1	R: fxd met flm 10 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R63	0684-2211			R: fxd comp 220 ohms +/-10% 1/4 W	01121	CB 2211
R64, R65	0684-4701			R: fxd comp 47 ohms +/-10% 1/4 W	01121	CB 4701
R66	0687-2721		1	R: fxd comp 2700 ohms +/-10% 1/2 W	01121	EB 2721
R67	0698-4384		1	R: fxd met flm 54.9 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R68	0757-0410		1	R: fxd met flm 301 ohms +/-1% 1/8 W	75042	CEA T-O obd
R69, R70	0757-0442			R: fxd 10 kilohms +/-1% 1/8 W	75042	CEA T-O obd
R71	0757-0410			R: fxd met flm 301 ohms +/- 1% 1/8 W	75042	Cea T-O obd
R72	0757-0401			R: fxd met flm 100 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R73	0698-4437		1	R: fxd met flm 2.94 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R74, R75	0684-2201			R: fxd comp 22 ohms +/-10% 1/4 W	01121	CB 2201
R76	0698-4437			R: fxd met flm 2.94 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1.
R77	0684-5621		1	R: fxd comp 5600 ohms +/-10% 1/4 W	01121	CB 5621
R78	0757-0161		1	R: fxd met flm 604 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R79A, R79B	2100-0447		1	R: var dual tandem 20 -30 dB 600 ohms +/-20%	01121	JJ89269C
R80, R81	0757-0161			R: fxd met flm 604 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R82	0684-2201		1	R: fxd comp 22 ohms +/-10% 1/4 W	01121	CB 2201
R83*	0684-1001		1	R: fxd comp 10 ohms +/-10% 1/4 W	01121	CB1001
S1	3100-1779			Switch: rotary 7 position	81840	obd
S1 Assy	00209-61901		1	Range switch assembly Includes mounted components.	-hp-	
S2	3101-1200		1	Switch: slide distortion DPDT	72927	7145 obd

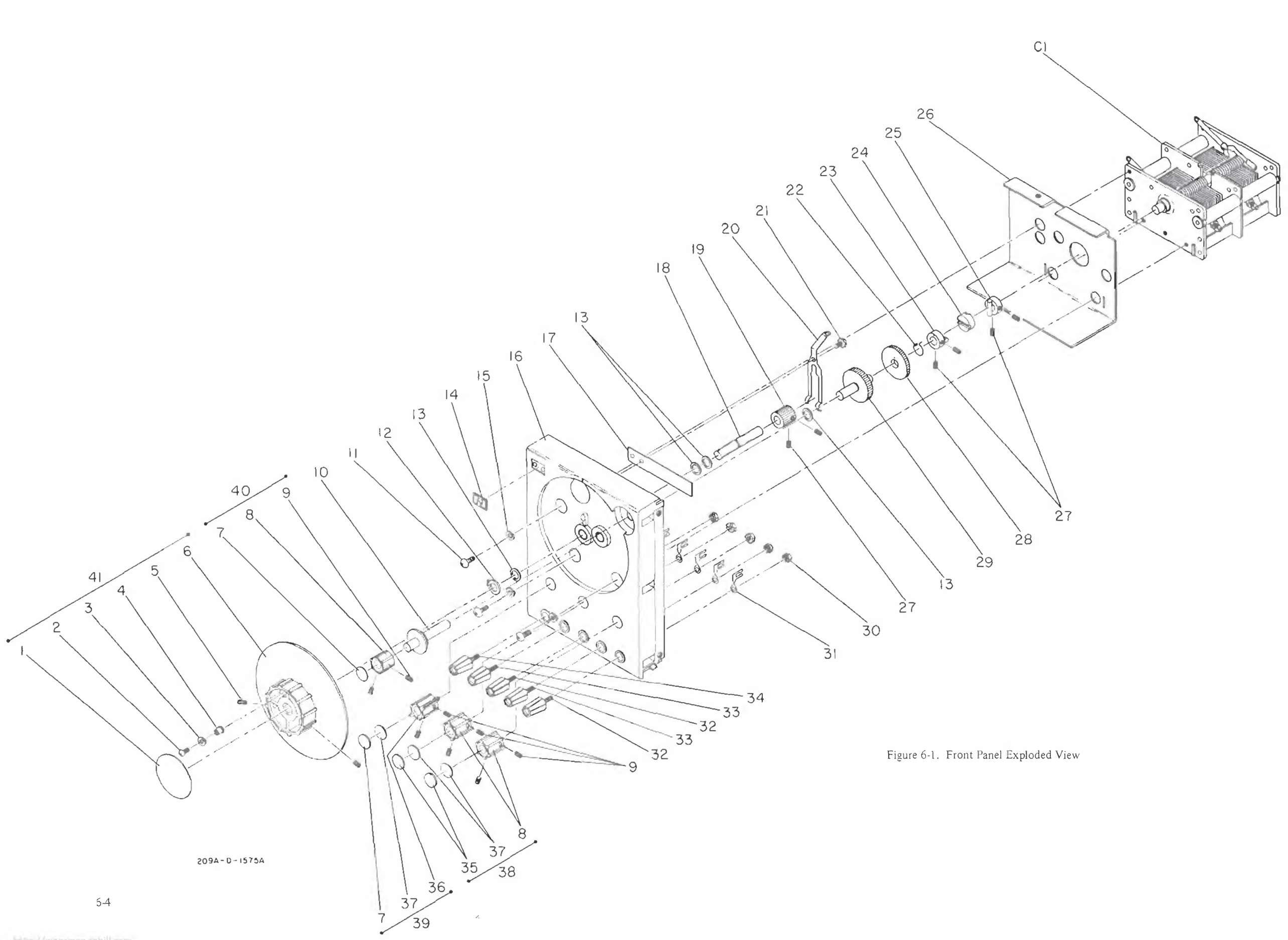


Figure 6-1. Front Panel Exploded View

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
				A2 POWER SUPPLY ASSEMBLY		
A2	00209-66512		1	Assembly: PC Board	-hp-	
C1, C2	0180-1802		1	C: fxd Al elect 150 uF +75% -10% 40 vdcw	56289	39D157G040EJr-DSB
C3, C4	0180-0094		1	C: fxd Al elect 100 uF +75% -10% 25 vdcw	56289	30D107G025DD2-DSM
CR1 thru CR4	1901-0158		1	Diode: Si 200 piv 0.75 amp	04713	SR1358-8
CR5	1902-0025		1	Diode: breakdown zener +/-5% 10 V	04713	SZ10939-182
CR6	1902-3150			Diode: breakdown zener 9.09 V +/-2%	04713	SZ10939-171
CR7	1902-0025			Diode: breakdown zener +/-5% 10 V	04713	SZ10939-182
Q1	1854-0039		1	TSTR: Si NPN 2N3053	04713	2N3053
Q2	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q3	1854-0071		1	TSTR: Si NPN**	-hp-	
Q4	1851-0017		1	TSTR: Ge NPN 2N1304	01295	2N1304
Q5	1853-0010			TSTR: Si PNP 360 mW 30 V	04713	SM4713
Q6	1854-0215			TSTR: Si NPN 2N3904	04713	SPS-3611
Q7	1853-0051		1	TSTR: Si PNP 2N4037	02735	obd
Q8	1850-0062		1	TSTR: Ge PNP 2N404	01295	GA 287
R1	0684-1811		1	R: fxd comp 180 ohms +/-10% 1/4 W	01121	CB 1811
R2	0757-0161			R: fxd met flm 604 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R3 thru R6	0684-3321		1	R: fxd comp 3300 ohms +/-10% 1/4 W	01121	CB 3321
R7	0757-0161			R: fxd met flm 604 ohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R8	0684-1811			R: fxd comp 180 ohms +/-10% 1/4 W	01121	CB 1811
R9	0684-4721		1	R: fxd comp 4700 ohms +/-10% 1/4 W	01121	CB 4721
R10	0698-3268		1	R: fxd met flm 11.5 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R11	0757-0442			R: fxd met flm 10 kilohms +/-1% 1/8 W	75042	CEA T-0 obd
R12	0757-0450		1	R: fxd met flm 22.1 kilohms +/-1% 1/8 W	91637	MFF 1/8 W T-1
R13	0757-0449		1	R: fxd met flm 20.0 kilohms +/-1% 1/8 W	91637	MFF 1/8 T-1
R14	0683-0395		1	R: fxd comp 3.9 ohms +/-5% 1/4 W	01121	CB 39G5
R15	0684-4711		1	R: fxd comp 470 ohms +/-10% 1/4 W	01121	CB 4711
R16, R17	0684-2231		1	R: fxd comp 22 kilohms +/-10% 1/4 W	01121	CB 2231
R18	0684-4711			R: fxd comp 470 ohms +/-10% 1/4 W	01121	CB 4711
R19	0683-0395			R: fxd comp 3.9 ohms +/-5% 1/4 W	01121	CB 39G5
T1	9100-1435		1	Transformer	-hp-	
				CHASSIS MOUNTED COMPONENTS		
C1	0121-0418		1	C: var air 2 sections	-hp-	
C2	0160-0378			C: dipped mica 27 pF +/-5%	72136	RDM15E270J5S
J1	1251-2357		1	Connector: AC Power Cord receptacle	82389	EAC-301
J2, J4	1510-0059		2	Binding post ass y. red insulator	-hp-	
J3, J5	1510-0058		2	Binding post ass'y: black insulator	-hp-	
J6	1510-0060		1	Binding post ass'y: blue insulator	-hp-	
S3	3101-0033		1	Switch: slide DPDT non-shorting 115/230 V	79727	6510D
W1	8120-1348		1	Assembly: cable 7.5 ft. AC power cord set	70903	KHS-7041
				MECHANICAL PARTS		
MP1	5000-7121		1	Insert Knob: large	-hp-	
MP2	2360-0197		1	Screw: machine	74919	obd
MP3	2190-0018		1	Washer: lock for No. 6 hardware	00011	obd
MP4	0510-0153		1	Nut: captive internal thread	83324	RPN 6-32 SC
MP5	3030-0033		2	Screw: set hex socket drive	56878	obd
MP6	00209-64001		1	Assembly: dial and knob	-hp-	
MP7	5000-0479		2	Insert knob: plain (vernier and range)	-hp-	
MP8	0370-0773		3	Knob: black vernier and amplifier	-hp-	
MP9	3030-0007		2	Screw: set hex socket drive	56878	obd
MP10	1500-0232		1	Disc Assembly: vernier drive	-hp-	
MP11	2510-0002		3	Screw: machine truss head	73076	obd
MP12	0510-0054		1	Ring: retuning steel	89462	55555-25-S-MD
MP13	3050-0180		4	Washer: fluorcarbon	78471	obd
MP14	7120-1254		1	Name Plate: logo	-hp-	
MP15	2190-0017		3	Washer: lock for NO. 8 hardware	73734	obd
MP16	00209-40201		1	Panel: front	-hp-	
MP17	00204-09102		1	Spring: vernier	-hp-	
MP18	00204-23702		1	Shaft: 1-3/4 x 1/4	-hp-	
MP19	00312-20052		1	Gear: pinion dual shaft	-hp-	
MP20	00204-09101		1	Spring: grounding	-hp-	
MP21	2360-0255		1	Screw: machine	83385	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO
MP22	1460-0105		1	Spring: torsion anti-backlash	91260	obd
MP23	1500-0214		1	Coupler: hub (spring hole) brass	99934	
MP24	1500-0004		1	Coupler: insulator nylon	99934	A-201-1 obd
MP25	1500-0253		1	Coupler: hub	99934	obd
MP26	00204-00105		1	Chassis: front	-hp-	
MP27	3030-0022		6	Screw: set hex socket drive	56878	obd
MP28	00204-22402		1	Gear: loading	-hp-	
MP29	00204-62401		1	Assembly: gear	-hp-	
MP30	2420-0001		3	Nut: hex steel nickel-plated	000L1	obd
MP31	5000-5881		5	Connector: binding post to PC board	-hp-	
MP32	1510-0059			Binding Post Assembly: red	-hp-	
MP33	1510-0058		2	Binding Post Assembly: black	-hp-	
MP34	1510-0060		1	Binding Post: blue	-hp-	
MP35	5000-0477		2	Insert Knob: pointer amplifier	-hp-	
MP36	0370-0772		1	Knob: bar range black	-hp-	
MP37	5000-7148		4	Insert Insulator: my	-hp-	
MP38	0370-0844		2	Assembly: amplitude knob	-hp-	
MP39	0370-0845		1	Assembly: range knob	-hp-	
MP40	0370-0846		1	Assembly: vernier knob	-hp-	
MP41	00209-64001		1	Assembly: frequency dial	-hp-	
				MISCELLANEOUS		
	5060-5918		1	Assembly: top cover	-hp-	
	1510-0056		2	Binding Post Assembly: black (rear panel)	-hp-	
	5000-5838		2	Bracket: top cover	-hp-	
	00209-69502		1	Chassis: shield	-hp-	
	00204-07601		2	Clip: battery	-hp-	
	1251-1631		1	Connector: PC 10 contact PC board mount	76530	66-710-10
	5000-0710		1	Cover: bottom	-hp-	
	5000-0702		2	Cover: side	-hp-	
	5060-0727		2	Foot Assembly	-hp-	
	5060-0702		2	Frame: side	-hp-	
	0403-0131		2	Guide: PC board gray inner box spacer	-hp-	
	1205-0033		2	Heat Dissipator: semiconductor Q1 and Q7	05820	NF-207
	0340-0424		2	Insulator: binding post black	-hp-	
	0340-0100		1	Insulator: binding post gray	-hp-	
	00209-90001		1	Manual: operating and service	-hp-	
	00204-00206		1	Panel: rear	-hp-	
	7120-0898		1	Plate: 115/230	hp-	
	5000-0634		1	Shorting Strap: left	-hp-	
	1490-0031		1	Stand: third module tilt	91260	obd

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains the circuit diagrams necessary for the maintenance of the Model 209A Sine / Square Oscillator. Included are schematic diagrams and component location diagrams.

7-3. SCHEMATIC DIAGRAMS.

7-4. The circuits contained within each assembly are shown in the schematic diagrams. These diagrams can be used to develop an understanding of the principles of operation and as an aid to troubleshooting.

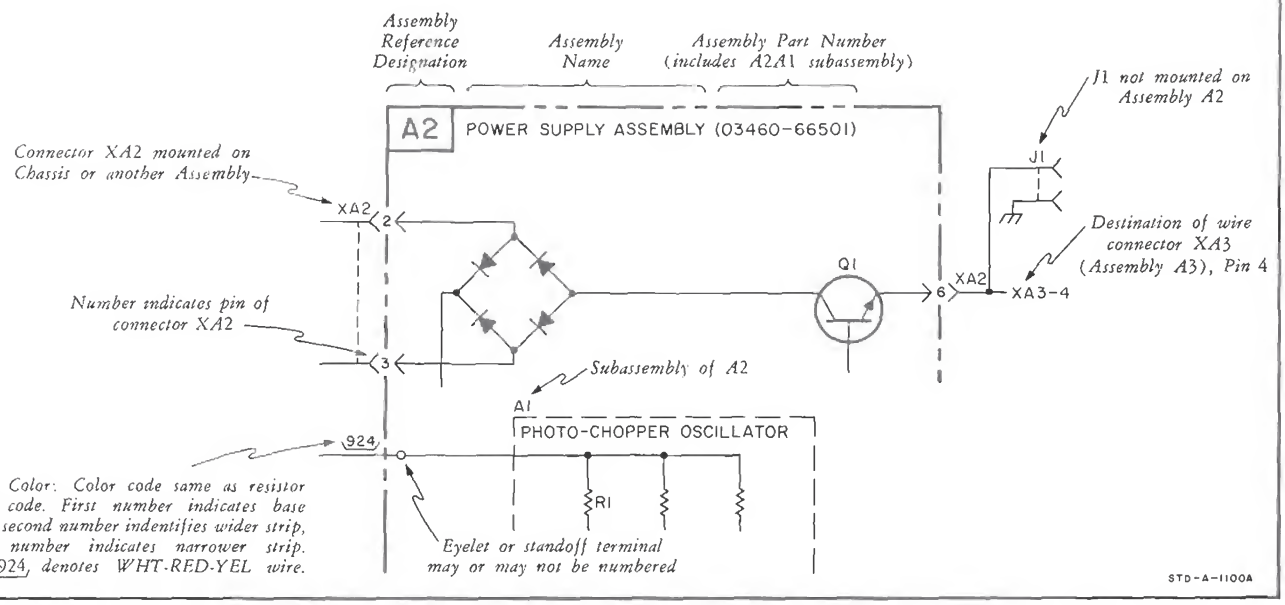
7-5. COMPONENT LOCATION DIAGRAMS.

7-6. The component location diagrams show the physical location of each part mounted on an assembly. Each part is identified by the reference designator used on the schematic diagrams and in the replaceable parts list.

REFERENCE DESIGNATIONS

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.

   RESISTANCE IN OHMS

   CAPACITANCE IN MICROFARADS

3. ⏚ DENOTES POWER LINE GROUND.

4. ⏚ DENOTES CHASSIS GROUND.

5. — - - — - - — - - — DENOTES ASSEMBLY.

6. ━━━━━━━━━━━━ DENOTES MAIN SIGNAL PATH.

7. ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ DENOTES FEEDBACK PATH.

8. ▭ DENOTES FRONT PANEL MARKING.

9. ▭ DENOTES REAR PANEL MARKING.

10. ⊖ DENOTES SCREWDRIVER ADJUST.

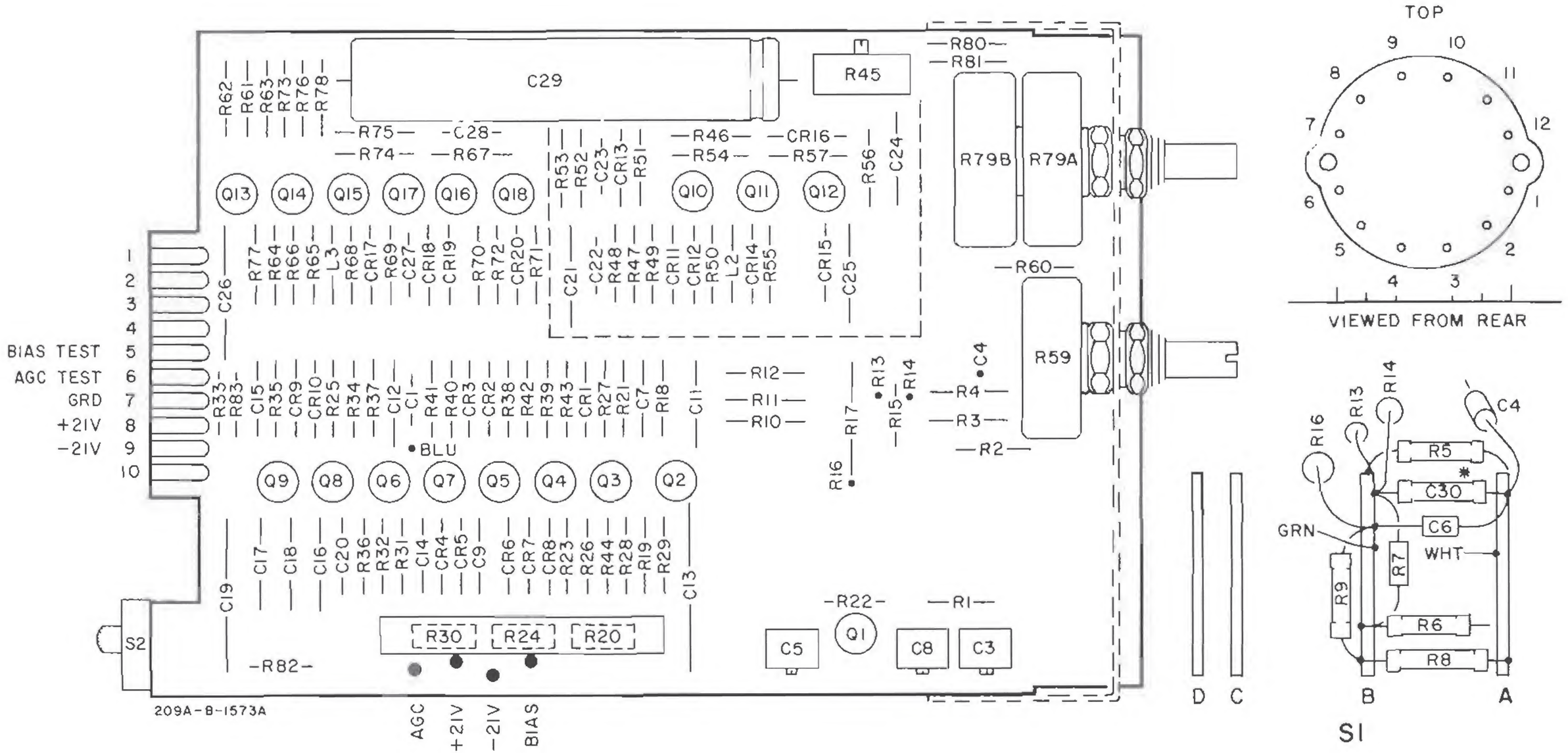
11. ◯ DENOTES FRONT PANEL CONTROL.

12. DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.

13. ✳ OPTIMUM VALUE SELECTED AT FACTORY.

14. † DENOTES FACTORY USE ONLY.

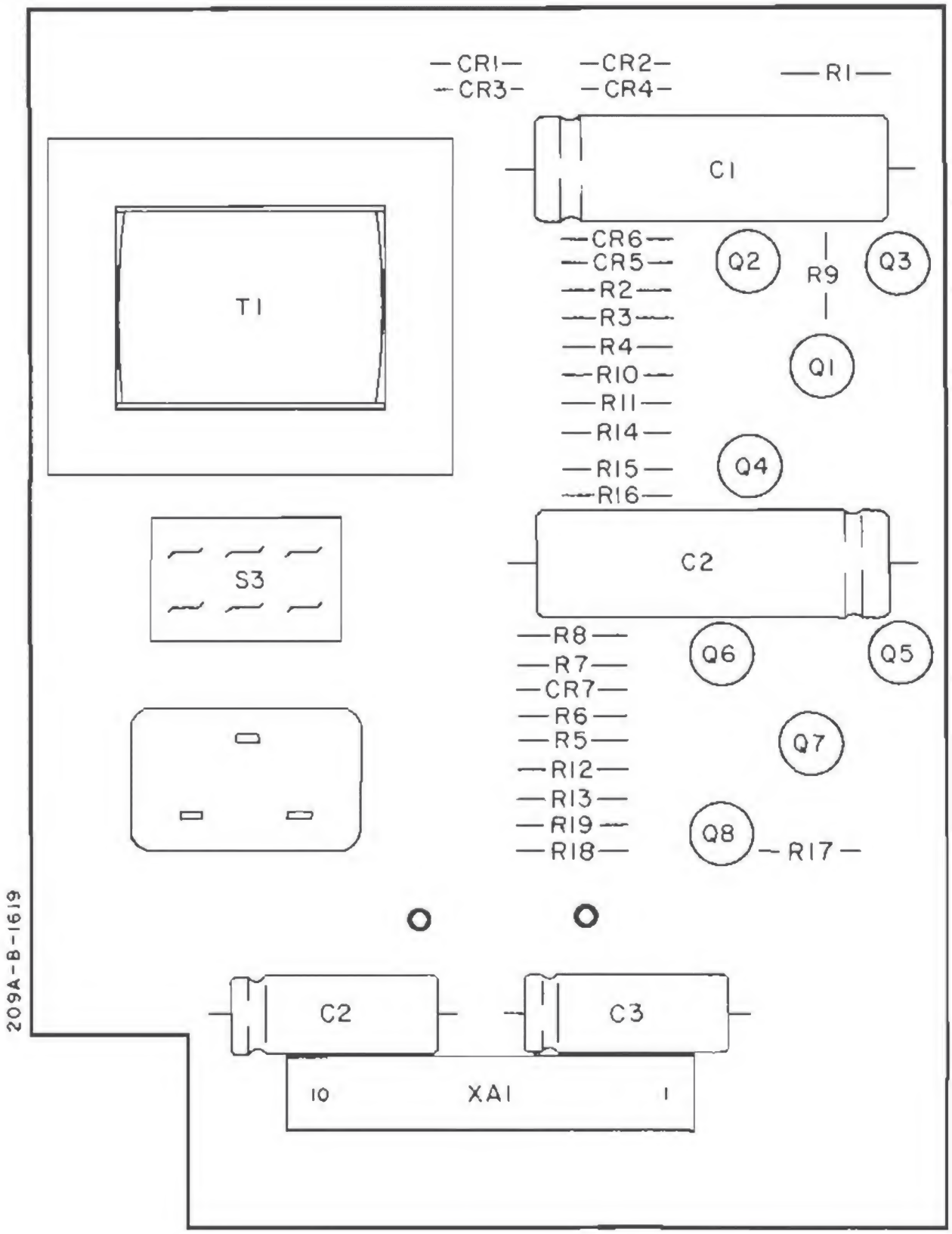
15. DC VOLTAGES WERE MEASURED WITH THE AGC ADJUST R24 FULLY CCW (OSCILLATOR DISABLED) AND FREQUENCY RANGE SET TO X10K.



A1

hp Part No. 00209-66501

REV D

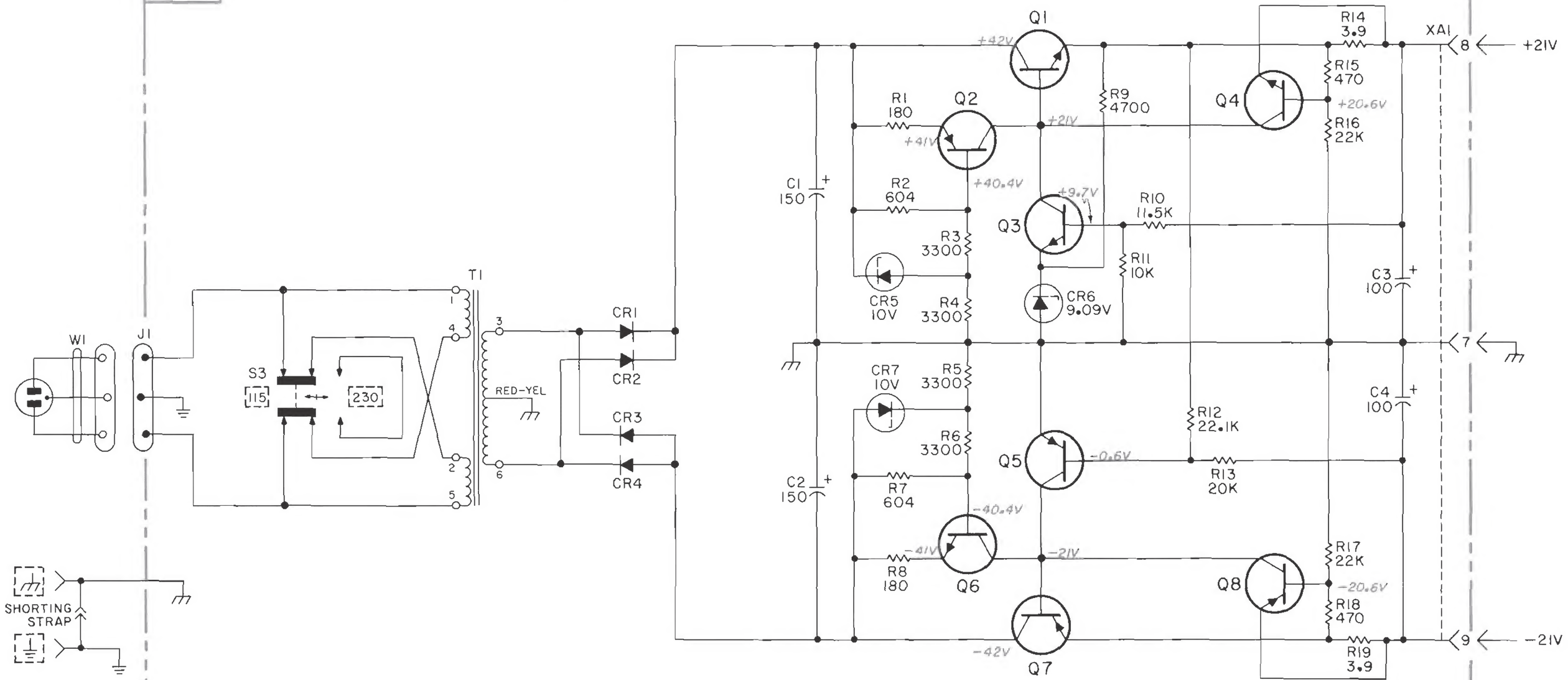


A2

hp Part No. 00209-66512

REV A

A2 POWER SUPPLY ASSEMBLY (00209-66502)



209A-C-1605A

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N. Y.
01930	Amerlock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co	Newark, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp	Compton, Calif.
03818	Parker Seal Co	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div. Finderne Plant	Somerville, N. J.
04009	Arrow Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amalom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div of C. B. S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15556	Micron Electronics	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Ma.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N. Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N. Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D. C.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Speciality Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	*Unimax* Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00327	Welwyn International Inc.	Westlake, Ohio

MANUAL BACKDATING CHANGES

Model 209A

Sine/Square Oscillator

Manual Serial Prefixed: 818-

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes
818-00800 and below	No. 1
818-00950 and below	No. 1, 2
818-01876 and below	No. 1, 2, 3

Instrument Serial Prefix	Make Manual Changes

CHANGE NO. 1 (818-00800 and below)
Table 6-1: Delete A1C30*.
Figure 7-1: Delete A1C30*.

CHANGE NO. 2 (818-00950 and below)
Table 6-1.
Change A1CR6 to "Diode: silicon" -hp- Part No. 1902-0041.
Change A1R43 to "R: fxd, 18 kilohms" -hp- Part No. 0684-1831.
Figure 7-1:
Show A1CR6 as a conventional diode.
Change the value of A1R43 to 18 kilohms.

NOTE (818-01776 and below)
Replacement of A1CR12

Tunnel diode (-hp- Part No. 1912-0009) is the replacement part for -hp- Part No. 1912-0026. The ANODE and CATHODE connections of the new diode are reversed with respect to the discontinued diode (see below figure).

NEW DIODE
(-hp- Part No. 1912-0009)
Case Marked 1N3712GE

DISCONTINUED DIODE
(-hp- Part No. 1912-0026)
Case Marked TD712GE

The replacement diode should be placed in the circuit with the case (CATHODE) away from the dot on the A1 printed circuit board.

CHANGE NO. 3 (818-01876 and below)

Table 6-1, page 6-5:

Change Part No. of A2 Power Supply Assembly to 00209-66502.

Change Part No. of J1 Connector to (1251-0148)

Page 6-6, Table 6-1 (Miscellaneous).

Change Part No. of power cord set to 8120-0078.

Figure 7-2:

Change component location diagram as shown below: